The Robotics and Autonomous Systems (RAS) minor is open to students majoring in Aerospace Engineering, Electrical and Computer Engineering, Mechanical Engineering, and Computer Science. The minor takes a multidisciplinary approach to robotics in which students gain knowledge about the design, control, programming, and integration of robotics and autonomous systems. With an emphasis on hands-on experiences, students will gain practical skills through coursework, group projects, and research. Students will have the opportunity to participate as peer mentors and tutors. The minor program will also include regular interactions with academic, corporate, and/or governmental leaders in robotics, who will serve as both mentors and professional contacts.

**Student Learning Outcomes**

1. Students will demonstrate the ability to apply advanced technical skills required to approach and resolve problems in the Robotics and Autonomous System (RAS) through upper-level RAS-related coursework in computer science and engineering disciplines.

2. Students will be able to apply the broad interdisciplinary aspects of RAS, such as the design, control, programming, and integration of complex robotic systems.

3. Students will obtain hands-on experience and demonstrate problem-solving skills in robotics through advanced coursework, experiential learning, and research.

4. Students will gain a sophisticated understanding of the range of professional opportunities available in RAS as a result of first-hand interactions with RAS faculty and professionals.

**REQUIREMENTS**

**Prerequisites**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH246</td>
<td>Differential Equations for Scientists and Engineers or ENES221 Dynamics</td>
<td></td>
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One of the following:

- CMSC131 Object-Oriented Programming I
- ENME202 Computing Fundamentals for Engineers
- ENAE202 Computing Fundamentals for Engineers
- ENEE150 Intermediate Programming Concepts for Engineers

**Requirements**

A minimum grade of C- or better is required for all minor and all prerequisite courses. A maximum of 2 courses may be used to satisfy the requirements of both a major and a minor.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ENME480</td>
<td>Introduction to Robotics</td>
<td>3</td>
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<tr>
<td>ENAE450</td>
<td>Robotics Programming</td>
<td>3</td>
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<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MATH240</td>
<td>Introduction to Linear Algebra</td>
<td>3-4</td>
</tr>
<tr>
<td>MATH340</td>
<td>Multivariable Calculus, Linear Algebra and Differential Equations I (Honors)</td>
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</tr>
<tr>
<td>MATH341</td>
<td>Multivariable Calculus, Linear Algebra, Differential Equations II (Honors)</td>
<td></td>
</tr>
<tr>
<td>MATH461</td>
<td>Linear Algebra for Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>ENEE290</td>
<td>Introduction to Differential Equations and Linear Algebra for Engineers</td>
<td></td>
</tr>
</tbody>
</table>

**Electives (select two courses):**

- ENME400 Machine Design
- ENME410 Design Optimization
- ENME413 Bio-Inspired Robotics
- ENME435 Remote Sensing Instrumentation
- ENME441 Mechatronics and the Internet of Things
- ENME461 Control Systems Laboratory
- ENME467 Engineering for Social Change or ENEE467 Engineering for Social Change
- ENME444 Assistive Robotics
- ENME476 Microelectromechanical Systems (MEMS) I
- ENEE440 Microprocessors
- ENEE460 Control Systems
- ENEE461 Control Systems Laboratory
- ENEE425 Digital Signal Processing
- ENEE426 Communication Networks
- ENEE408 Capstone Design Project (ENEE408I Capstone Autonomous Robotics)
- ENAE380 Flight Software Systems
- ENAE403 Aircraft Flight Dynamics
- ENAE432 Control of Aerospace Systems
- ENAE441 Space Navigation and Guidance
- ENAE488 Topics in Aerospace Engineering (ENAE488O Introduction to Autonomous Multi-Robot Swarms)
- CMSC421 Introduction to Artificial Intelligence
- CMSC422 Introduction to Machine Learning
- CMSC426 Computer Vision
- CMSC427 Computer Graphics
- CMSC451 Design and Analysis of Computer Algorithms
- CMSC498 Selected Topics in Computer Science (CMSC498E Robotics)

**Total Credits:** 21-22

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1 Students may waive this requirement if they complete the course for another minor or major.